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THE HAWAIIAN VIOLACEAE

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The Violaceae are represented in the Hawaiian flora by 14 species and varieties—11 in the genus *Viola* and 3 in *Isodendrion*. It is noteworthy that these are all endemic, ligneous, and shrubby. The genus *Isodendrion* Gray is endemic. Most of the species and varieties are highly precinctive and give evidence of having been members of the Hawaiian flora for a very long time.

The Hawaiian violets have been studied by a number of taxonomists, as is indicated by the following select bibliography:

- 1826 Gingins in *Linnaea* 1: 408
1854 Gray in *Botany of the U. S. Exploring Expedition*
1866 Mann in *Enumeration of Hawaiian Plants*
 Flora of the Hawaiian Islands
1888 Hillebrand in *Flora of the Hawaiian Islands*
1897 Heller in *Plants of the Hawaiian Islands*
1908 Forbes in *New Hawaiian Plants*
1909 Forbes in *New Hawaiian Plants*
1911 Rock in *Notes upon Hawaiian Plants*.

Practically all of this material is very rare and inaccessible outside of large botanical libraries.

The present paper is, however, the first comprehensive account which has included all of the recorded species and varieties. It is based upon field work extending over nearly ten years and contains new ecological material.

The genus *Viola* comprises about 200 species, widely distributed throughout the world, but most abundant in temperate regions. The tribe *Violae*, to which *Viola* belongs, occurs chiefly

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in Europe, Siberia, and North America; the woody species, of which the Hawaiian forms are representative, are mainly natives of tropical America. The *Violas* are leafy-stemmed or stemless herbs, or small shrubs; the Hawaiian species sometimes reach a height of 6 feet. The leaves are alternate, with persistent stipules. Most species produce two sets of flowers. The early set is showy, petaliferous, often fragrant, and usually sterile. This is succeeded by a set of cleistogamous flowers that are usually without petals, and never expand, but bear abundant seed. These small apetalous cleistogamous flowers are very fertile and quite diverse in structure, and are of great taxonomic value. The 5 imbricate, persistent sepals are generally produced at the base below their insertion. The 5 petals are unequal, the lowest one spurred, forming a nectar sac. The 5 stamens are hypogynous, alternate with the petals, and on short filaments or subsessile. They closely surround the ovary, with their connective prolonged beyond the apex; the 2 lowest with appendages that project into the spur. In the cleistogamous flowers these two stamens alone develop.

The ovary is simple, 1-celled, with 3 parietal placentae. The capsule is 3-valved, loculicidal, and opens elastically when mature. The valves spring back and at the same time fold on the middle, so that the seeds are forcibly ejected. The seeds are anatropous, with a hard testa and copious albumen; ovoid-globose; embryo straight, axile; cotyledons flat.

It is well known that allied species of *Viola* hybridize freely when growing together, and it is possible that some of the Hawaiian forms have originated in this way. The hybrids commonly display characters which are more or less intermediate to those of the parent species. The offspring of the hybrids are frequently much unlike the parent stock and unlike each other, and revert to the characters of the two original species.

The Hawaiian *Violas*, like those of other parts of the world, contain an alkaloid which possesses emetic and laxative properties. Several species were used medicinally by the primitive Hawaiians for skin diseases, as emetics, etc.

The endemic genus *Isodendrion* is distinguished from *Viola*

by the fact that the petals are equal, not spurred, and the anthers are not appendiculate. The three species, which strongly resemble the true violets, are shrubs with entire leaves and persistent, rather intrapetiolar, keeled stipules. The flowers are small, axillary, solitary, and shortly pedicellate. The sepals are equal, persistent. The petals are nearly equal, linear-spathulate; the long claws erect and contiguous, the broader blades spreading, imbricate. The filaments are short, distinct, the anthers connivent around the ovary, their connective neither spurred nor prolonged above. The style is elongate, slightly curved and thickened near the apex, with anterior stigma. The capsule is coriaceous, surrounded by the withered corolla, 3-valved, the placentae along the middle of the conduplicate valves, with 2-4 seeds. Seeds obovoid, smooth, crustaceous.

Viola and *Isodendrion* are distributed rather generally throughout the larger islands of the archipelago, both in the montane rain-forests and summit bogs, and in semi-arid districts. The range by islands is shown in the following table:

Name	Kauai	Oahu	Molokai	Maui	Lanai	Hawaii
1. <i>Viola Chamissoniana</i> . . . . .	*	*	*	*	.....	.....
2. <i>Helena</i> . . . . .	*	.....	.....	.....	.....	.....
3. var. <i>Laniaensis</i> . . . . .	.....	.....	.....	.....	*	.....
4. <i>helioscopia</i> . . . . .	.....	*	.....	.....	.....	.....
5. <i>Kauaiensis</i> . . . . .	*	.....	.....	.....	.....	.....
6. <i>Mauiensis</i> . . . . .	.....	.....	*	*	.....	.....
7. var. <i>Kohalana</i> . . . . .	.....	.....	.....	.....	.....	*
8. <i>Oahuensis</i> . . . . .	.....	*	.....	.....	.....	.....
9. <i>robusta</i> . . . . .	.....	.....	*	.....	.....	.....
10. var. <i>Mauiensis</i> . . . . .	.....	.....	.....	*	.....	.....
11. var. <i>Wailenalena</i> . . . . .	*	.....	.....	.....	.....	.....
12. <i>Isodendrion pyrifolium</i> . . . . .	.....	*	.....	.....	.....	.....
13. <i>longifolium</i> . . . . .	*	*	.....	.....	.....	.....
14. <i>laurifolium</i> . . . . .	.....	*	.....	.....	.....	.....
Totals	5	6	3	3	I	I

It will be noted from the above table that the older islands, to the west, are richer in species and varieties than are the relatively younger islands to the east. Kauai and Oahu possess 9 forms; Maui and Hawaii but 4. Ten species and varieties are strongly hygrophytic; 4 have been recorded from semi-xerophytic habitats. The ecologic range is striking; on one hand are the exces-

sively humid summit bogs, on the other the dry, open, exposed, wind-beaten ridges and foothills.

<i>Hygrophytic</i>	<i>Xerophytic</i>
<i>Viola Chamissoniana</i>	<i>Viola helioscopia</i>
<i>Helena</i> and var. <i>Lanaiensis</i>	<i>robusta</i> var. <i>Mawiensis</i>
	<i>Isodendrion pyriformium</i>
<i>Kauaiensis</i>	<i>laurifolium</i>
<i>Mawiensis</i> and var. <i>Kohalana</i>	
<i>Oahuensis</i>	
<i>robusta</i> and var. <i>Wailenalena</i>	
<i>Isodendrion longifolium</i>	

The vertical range extends from 1,000 to 6,000 feet. On the very high mountains of Maui and Hawaii (8,000 to nearly 14,000 feet) they rise to higher levels, as do many other plants of the middle and lower forest zones.

DESCRIPTIONS OF THE SPECIES

The following descriptions have been taken from the original sources, with emendation, revision, and additional material.

1. *Viola Chamissoniana* Gingins. Described in *Linnaea* I: 408, 1826.

An erect, branching shrub, 3-5 feet high. Stem woody, fine-grained, $\frac{1}{2}$ -1 in. thick. Branches diffusely foliose. Stipules dark, scarios, 2-4 lines, broadly deltoid, entire and long-acuminate, or glandular-dentate. Petioles 1-2 in. Blade cordate, those of the upper leaves rarely ovate, 3-6 in. by 1-2 $\frac{1}{2}$ in.; dentate with appressed callous teeth, chartaceous, glabrous.

Peduncles 1 or 2 to a branch, $\frac{1}{2}$ -1 $\frac{1}{2}$ in. long, with 2 subulate bracts above the middle; single-flowered, the flowers large and handsome. Sepals narrow lanceolate, 2-4 lines, shortly pointed at the base. Petals pink, rose, or purplish, twice as the sepals long or more, oblong-spathulate; the lowest petal deeply saccate. Anthers 1 line long, with narrow connective and short, broad terminal appendage; the 2 lowest anthers with a long, broad, obtuse spur. Capsule 6 lines long, with 6-8 obovoid, blackish seeds in each placenta.

Dimorphism is indicated by the occasional occurrence of well-developed diminutive flowers not exceeding 3 lines in length, with petals scarcely longer than the sepals.

Occurs on all the islands, except possibly Hawaii, at elevations of 1,000-4,000 ft. in the rain-forests. Native name "*Pamakani*."

Var. *beta* Hillebrand, Flora, p. 17, 1888, has the young shoots and inflorescence puberulous with a silvery-gray tomentum; old leaves pubescent. Leaves serrate with uncinatate teeth; stipules large, 6 lines long; flowers whitish. Confined to the Wai-ale-ale rain-forests of Kauai, at about 3,000 feet. Native name "*Olopu*."

2. *Viola Helena* Forbes. Described in Occ. Papers Bishop Museum, vol. 4, no. 3, 1908, p. 42 and plate.

"Plant 1-2 feet high. Leaves lanceolate, tapering at both ends, glandular-serrate, 3-4½ lines long by 7-9 lines wide, with petioles of 2-3 lines.

"Scapes or peduncles 1 or 2 on a stem, 2-3 lines, with 2-3 linear bracts, bearing an umbel of 2 flowers on pedicels of 10-14 lines which have bractlets of about 1 line. Sepals lanceolate, 2 lines long. Petals a little more than twice as long, the lower saccate, white or pale lavender, the lower and lateral ones bearded. Capsule glabrous, 7 lines long."

Recorded only from the Wahiawa Mountains of Kauai; hygrophytic.

3. *V. Helena* var. *Lanaiensis* Rock. Described in College of Hawaii Bulletin 1, 1911, p. 6.

"Caudex erect, 3 dm.-13 dm. long, woody, hollow, foliose at the apex. Leaves oblong-lanceolate, about 1 dm. × 12-18 mm., acuminate at both ends, on somewhat margined petioles of 5 mm., serrate with callous teeth; bluish-purple when young, light green with pellucid oil-dots when old; stipules lanceolate, 1 cm. long, caudate-fimbriate, blackish, with a prominent median vein.

"Peduncles bi-bracteate, 1.5 cm. with a bi-bracteolate pedicel of 4.5 cm. long, bearing a single small, pinkish-white flower; sepals lanceolate, not saccate. Capsule lanceolate, 12 mm. long; seeds ovoid, blackish."

Recorded only from the island of Lanai, 2,000-3,200 feet; hygrophytic.

4. *Viola helioscopia* Hillebrand. Described in his Flora of the Hawaiian Islands, 1888, p. 17.

An erect shrub, 2-3 feet high, with a few slender wand-like branches foliose at the top. Stipules deltoid-subulate, fringed with long, glandular fimbria. Leaves coriaceous, glabrous,

ovate, 1-1½ in. long by 1 in. wide, acuminate, serrulate; the truncate base passes abruptly into a petiole of 2-4 lines.

Peduncles generally 2 to a branch, ascending, 1½-2 in. long. Each bears a single large, erect, showy flower, and is bi-bracteolate a short distance from the calyx. The sepals are narrow-lanceolate, 4 lines long, drawn out at the base into a short appendage. The petals are 8-14 lines long, broad-oblong or orbicular, on long claws, the lowest petals saccate; color pure waxy white. Capsule 6 lines long; seeds dark.

Recorded only from the Waianae Range of Oahu, on dry, open, semi-xerophytic ridges. A very handsome species, worthy of horticultural experimentation.

5. *Viola Kauaiensis* Gray. Described in the Botany of the United States Exploring Expedition, 1854, p. 85.

Stem either short and erect, or a creeping or trailing rhizome which may be more or less subterranean. Rhizome 2-3 lines in diam., scaly near the apex with obtuse stipules, and bearing (besides the remnants of older ones) 1 or 2 slender scapes 4-8 in. long. These scapes have 1 internode and a single leaf and flower, or with 2 internodes and a second leaf and flower. Petioles slender, 2-6 in. long. Blade broadly ovate, orbicular, or reniform, with a cuneate base, less than 1 in. diam., rather thick with prominent subflabellate veins; margin crenate, surface glabrate. Stipules deltoid, 2-3 lines long, with a few short teeth.

Petaliferous flowers on peduncles of 2-4½ in., which bear a pair of short subulate bracts in the upper portion. Sepals 3½ lines long, narrow-lanceolate, the base produced into a short appendage. Petals twice as long, pale blue, not bearded, oblong-spathulate, the lowest one slightly saccate. Anthers free, half as long as the sepals, attached to the anterior face of a broad connective which fringes them and extends above in the shape of a hood. The 2 lowest anthers have a short dorsal keel near the base. Style curved, clavate above, with anterior stigma. The smaller flowers have petals not exceeding the calyx; stamens with distinct filaments nearly equalling the petals; style thicker and hooked. Capsule acute, 5-6 lines long, with 8-10 seeds in each placenta.

Recorded only from the swamps on the upper slopes and summit of Wai-ale-ale, Kauai, 4,000-5,250 feet. It grows in the shade of the stunted *lehua* trees (*Metrosideros polymorpha*) that are characteristic of these swamps, and also epiphytically on the

moss-covered tree-trunks. It is strongly hygrophytic. Native names "*Pohehiwa*" and "*Kalili*."

6. *Viola Mauiensis* Mann. Described in Enumeration of Hawaiian Plants, no. 11, 1866.

Stem simple, or dividing at the base, prostrate or ascending, woody below, a few inches to 2 feet long. Its upper portion is covered with dark brown, sharply cut, long-acuminate stipules, and foliose near the apex. Leaves on petioles of about 1 inch, coriaceous, glabrous, broadly ovate and obtuse or rounded, 1-1½ in. diam., truncate or cuneate at the base, serrulate with callous teeth.

Scapes or peduncles 1-3 on a stem, 2-6 in. long, with 2 narrow acute bracts about the middle, bearing an umbel of 2-4 flowers on pedicels of 1 inch, which are again bracteolate. Sepals narrow-lanceolate, 4 lines, purplish, scarcely produced at the base. Petals twice as long, unguiculate, obovate, dark blue, the lowest saccate. Anthers oblong, 1-1½ lines long, not margined, tipped with a short papilla, the 2 lowest broadly spurred. Style curved, thickening toward the stigma. Capsule 6 lines long, with 8-10 seeds to the placenta.

Characteristic of the summit bog of West Maui, but also recorded from the Kawela swamps of East Molokai, 4,000 feet. Strongly hygrophytic.

7. *V. Mauiensis* var. *Kohalana* Rock. Described in College of Hawaii Bulletin 1, 1911, p. 5.

"Caudex 10-16 dm. long, woody, more or less prostrate. Stipules ovate-lanceolate, reddish-brown. Leaves like the species, on petioles of 2-7 cm. Peduncles blackish-blue when with dark blue flowers, light yellow when with white flowers; bearing umbels of blue or white flowers on bi-bracteolate pedicels of 3-9 cm. length; capsules as for the species."

Recorded only from the summit bogs of the Kohala Mountains, island of Hawaii, at altitudes of 4,600-5,200 feet. "The flowers are very fragrant and large, the dark blue-flowered specimens occurring down to an elevation of 4,600 feet, while the white ones are found only higher up, 5,200 feet elevation. . . . This variety differs from the species in its very long caudex, scapes, and petioles, as well as pedicels and in its large flowers which are also white." It grows both in the swampy soil and epiphytically on mossy tree-trunks.

8. *Viola Oahuensis* Forbes. Described in Occ. Papers Bishop Museum, vol. 4, no. 3, 1909, p. 40 and plate.

"Stem erect, simple or sparingly branched, 6 in. to 1 foot high. Leaves 4.5-5 × 2-2.25 in., ovate, uneven-sided, glandular-serrate, acute, base acuminate, drawn out into a winged petiole of 1 inch. Stipules lanceolate, glandular-serrate, acuminate, 7-14 lines.

"Scapes or peduncles 1-3 on a stem, 9 lines long, with 2 narrow acute bracts and a reduced leaf, bearing 2 flowers on peduncles of nearly equal length, about 2 in., these bracteolate and often with a reduced leaf. Sepals lanceolate, faintly puberulent, 3 lines long. Petals about twice as long, white, broad, oblong to orbicular, the lower saccate, not bearded. Capsule a little over 5 lines long, glabrous."

Recorded only from the Koolau Range, Punaluu and Kahana sections, on the island of Oahu, at altitudes of 1,800-2,000 feet. Hygrophytic.

9. *Viola robusta* Hillebrand. Described in his Flora of the Hawaiian Islands, 1888, p. 16.

Stem 3-5 feet high, light-wooded, pale, about ½ in. thick at the base. It is simple or sparingly branched in the upper portion. The ascending branches are hollow, herbaceous at the extremities, and carry many old and dry flower-stalks. The stipules are long, persistent, dark, broadly lanceolate, long-pointed, denticulate, and about ½ in. long. Leaves membranous, puberulous underneath, ovate, acute, serrulate, 3-4½ in. long by 2-2½ in. broad; base truncate or cuneate; petiole 1-1½ in. long.

Flowers nodding, numerous; an inflorescence rises from nearly every axil. The flowers are generally single, or 2-4 irregularly disposed on a peduncle of very variable length. Pedicels 2 in. long, bi-bracteolate about the middle, the bracts long-subulate from a broad base, but often foliaceous. Sepals gibbous at the base, but not produced, narrow-lanceolate, 3-4 lines long. Petals twice as long, pale purple, oblong, the lowest saccate, the 4 upper ones converging, assurgent. Anthers shortly apiculate, the 2 lowest with a narrow dorsal wing along their whole length, which does not run out into a spur. Capsule 8-10 lines long, with 8-14 pale seeds on each placenta.

Recorded only from the summit bogs of East Molokai, in very wet situations, at altitudes of 2,500-4,000 feet. It grows in the swampy soil, and on the mossy trunks of trees. Native name

"*Pamakani*"; like several other species, it is used medicinally by the Hawaiians, who make a decoction of the foliage.

10. *V. robusta* var. *Mauiensis* Rock. Described in College of Hawaii Bulletin 1, 1911, p. 6.

Habit as for the species. Leaves with hirsute midribs. Blade oblong, ovate, subcordate, or truncate. Petioles hirsute, 1.5-2.5 cm. Stipules triangular from a broad base, acuminate, ciliate on the margins. Peduncles bibracteate, hirsute, 2-4 cm. long, one-flowered, (never two) in the axils of every leaf. Calyx hirsute, linear-lanceolate, acuminate. Petals pinkish. Capsule 1.5 cm. long. Seeds ovoid, blackish.

Recorded only from the middle slopes of Mount Hale-a-ka-la, island of Maui, at altitudes of 3,500-5,000 feet. In semi-xerophytic gulches. Native name "*Pamakani*"; used medicinally.

11. *V. robusta* var. *Wailenalena* Rock. Described in College of Hawaii Bulletin 1, 1911, p. 6.

Stem 1-2 m. high, the branches as well as the stems hollow. Stipules light brown, broadly lanceolate, acuminate, about 3 cm. long, denticulate or serrate almost to the base. Leaves thick, fleshy, light green underneath, darker above; 9-10 cm. long by 3-4 cm. broad; ovate, acuminate at base and apex, serrulate with the base entire; midrib and petiole dark purple; petiole 4 cm. long.

Flowers in the axils of the upper leaves; single or two on a short bi-bracteate peduncle. Pedicels 4-5 cm. long, bi-bracteolate above the middle. Flowers nodding; sepals gibbous at the base, 1 cm. long. Petals white, not fragrant; twice as long as the sepals; the lower saccate. Anthers apiculate, all winged. Style curved, thickening toward the stigma. Capsule hirsute when young.

Recorded only from the high, swampy plateau of Wai-ale-ale, island of Kauai, along Wai-lena-lena Stream, altitude 4,500 feet.

12. *Isodendron pyrifolium* Gray. Described in the Botany of the United States Exploring Expedition, 1854, p. 93, pl. 8.

A spreading shrub, 2-3 feet long, the wand-like branches with short branchlets. The branchlets are foliose near the apex and covered for some distance below with narrow, lanceolate or subulate, silky-haired converging stipules, 1½-2 in. long. Leaves membranous, pubescent when young, ovato- or elliptico-oblong, obtuse, crenate, 1½-2 in. long by ¾-1 in. wide, on petioles of 3-5 lines.

Pedicels single, 2-4 lines long, pubescent, with a pair of rather broad scarious bractlets at the middle. Sepals connected at the base, $2\frac{1}{2}$ -3 lines, lanceolate, silky, scarious with thin margins. Petals 5-6 lines long, rather thick, greenish-white. Stamens nearly half the length of the sepals, the anthers as long as the filaments. Style almost straight, of even height with the petals. Capsule 6 lines long, each placenta with 2-5 obovoid pale seeds. The flowers are fragrant.

On all the islands, from Niihau to Hawaii, in the scrub vegetation on the semi-xerophytic foothills and exposed open ridges, at elevations of 1,000-3,000 feet. Native name "*Aupaka*."

- ✓ 13. *Isodendrion longifolium* Gray. Described as above, loc. cit., p. 95, pl. 9.

A glabrous shrub reaching a height of six feet or more, with rather stout branches and scattering leaves. Stipules erect, triangular or lanceolate, $1\frac{1}{2}$ -2 lines long. Leaves chartaceous, pale, shining, obovate-oblong, obtuse or shortly acuminate, gradually narrowing to the base, repandly crenate or subentire, 6-8 in. long by 2-2 $\frac{1}{2}$ in. broad, on short petioles of $\frac{1}{4}$ -1 in.

Flowers single, from short and thick bracteate spurs, the naked pedicels $1\frac{1}{2}$ lines long. Sepals 2 lines long, glabrous. Petals twice as long, strap-shaped, scarcely dilated above, purplish-white. Stamens as for 12, the filaments curved. Capsule 3-5 lines long.

Confined to the island of Kauai, Wai-ale-ale, and the Waianae Range on Oahu, Ka-ala, at elevations of 2,000-3,000 feet.

- ✓ 14. *Isodendrion laurifolium* Gray. Described as above, loc. cit., p. 96.

A small glabrous shrub, the stipules subulate, brownish. Leaves oblong, acute, rounded at the base, repandly crenate or subentire, pale below, chartaceous, shining, 3 $\frac{1}{2}$ in. long by 1 in. broad, on petioles of 1-2 lines.

Flowers single, bi-bracteolate, on pedicels of 1-2 lines, or the pedicels on bracteate spurs and naked. Other data not known.

Recorded only from the Koolau Range, island of Oahu, on exposed ridges of Wailupe Valley, a semi-xerophytic region. Little is known concerning this rare and highly localized species.

The following table will aid in roughly distinguishing the Hawaiian violets:

Name	Stature, Feet	Color of Flowers	Fragrance
<i>V. Chamissoniana</i>	3-5	Pink, rose, purple	
<i>Helena</i>	1-2	White, pale lavender	
var. <i>Lanaïensis</i>	1-4	Pinkish-white	
<i>helioscopa</i>	2-3	Pure waxy white	Yes
<i>Kauiensis</i>	1-3	Pale blue	
<i>Maiensis</i>	1-2	Dark blue	
var. <i>Kohalana</i>	4-6	White to dark blue	Yes
<i>Oahuensis</i>	$\frac{1}{2}$ -1	White	
<i>robusta</i>	3-5	Pale purple	
var. <i>Maiensis</i>	3-5	Pinkish	
var. <i>Wailenalanae</i>	3-6	White	
<i>I. pyriformis</i>	2-3	Greenish-white	Yes
<i>longifolium</i>	6-8	Purplish-white	
<i>laurifolium</i>	2-3?		

COLLEGE OF HAWAII,
HONOLULU

A NEW HYBRID SUNFLOWER

BY T. D. A. COCKERELL

In 1895 Rydberg described a supposed species *Helianthus aridus*, which occurred in the region of *H. petiolaris* and *H. annuus lenticularis*, and appeared to be a possible hybrid between the two. Another form, known as *H. petiolaris* var. *patens* (Lehm.) Rydb., was also suspected of being a hybrid.* It was therefore particularly desirable to produce a genuine *petiolaris* \times *annuus* hybrid, for comparison with these more or less intermediate forms. My wife made the crosses last year, and this year we have the resulting plants in large numbers. The *petiolaris*, used as the seed plant, was a specially fine but typical plant raised from seed collected by Mr. D. M. Andrews in Oklahoma. The *annuus* were various, including chestnut-red (*coronatus*) forms. The *H. petiolaris* was perfectly fertile with the *annuus* pollen, and the hybrids are all alike in general appearance.

Helianthus annuus \times *petiolaris*, n. hybr.

Plants about four feet high, freely branching, the growth essentially like *petiolaris*; stems and branches hairy, more or less speckled with purple; leaves alternate, rarely opposite, the petioles about equal to the blades, or often shorter; leaf-blades with

* American Naturalist, XLIX (1915), pp. 611-613.